CHAPTER 4

CIVIL AND SITE ENGINEERING AND WASTEWATER AND STORM WATER MANAGEMENT

4-1. General civil, site, and waste management design

These criteria shall be applied in the planning, design and implementation of projects involving site development, sanitary wastewater collection systems and storm water management systems. Their purpose is to provide the minimum requirements for the preparation of site-specific general design criteria and project-specific design criteria during the project planning phase. Many of the departmental organizations have responsibilities for facility planning, design, and construction; therefore, the particular organization may establish and apply more comprehensive criteria to satisfy the particular program mission or operating requirements. The general design criteria need not take precedence over such other criteria, where those criteria meet or exceed the general design requirements.

4-2. Site development

The design agency shall consider the following site development criteria when locating new C4ISR facilities and buildings.

a. A site development plan shall be used to locate new facilities on existing or new sites to assure effective site utilization and to preclude future conflicts between existing and new facilities.

(1) During site selection for new facilities, the following conditions and requirements shall be considered.

(a) Natural topographic and geologic conditions

(b) Existing cultural, historic, and archaeological resources

(c) Endemic plant and animal species

(d) Health, safety, and environmental protection requirements

(e) Indoor air quality impacts (e.g., presence of radon in foundation soils, building materials that off-gas irritating chemical vapors, and the need to “bake out” new buildings prior to occupancy)

(f) Hazardous operations and consequences of potential accidents in adjacent facilities

(g) Natural hazards including seismic activity, wind, hurricane, tornado, flood, hail, volcanic ash, lightning, and snow

(h) Wave action within any natural or man-made body of water

(i) Physical protection requirements

(j) Adequacy of existing or planned support and service facilities, including utilities, roads, and parking areas

(k) Interrelationships between facilities and aesthetic compatibility

(l) Energy conservation requirements

(m) Impact of site selection

(n) Utility maps should be researched and reviewed to verify the location of any buried gas pipes, buried electrical cables, underground supplied water system, sewer systems, etc.

(2) The prior use (e.g., spoil area, buried man-made objects and utilities, ponds, burial grounds, etc.) of the site shall be investigated as part of the location analyses for facility siting. To the extent possible, facility siting shall preclude the use of floodplains or areas subject to flash floods and shall minimize destruction, loss, or degradation of wetlands.

b. New buildings and building additions shall be located in accordance with the site development plan. Open space shall be provided between structures (to accommodate site security, landscaping, and other environmental considerations). Sufficient access shall be provided around building exteriors (to accommodate emergency vehicles, maintenance vehicles, and snow removal equipment). In cold climates, building entrances, stairs, and other pedestrian circulation features should not be placed along the north side of buildings or within shaded areas. During site selection for new buildings, the following conditions and requirements shall be considered.

(1) Architectural and functional compatibility with the environment

(2) Operation and service functional relationships

(3) Natural topographic and geologic conditions

(4) Existing cultural and archeological resources

(5) Historical sites

(6) Abandoned mines or wells and potential for subsidence

(7) Endemic plant and animal species

(8) Availability of existing utility services

(9) Building setback requirements

(10) Availability of existing road systems

(11) Traffic volume

(12) Refuse handling and loading zone requirements

(13) Adequacy for parking, future expansion and other land use requirements

(14) Health, safety, and environmental protection requirements

(15) Indoor air quality impacts (e.g., presence of radon in foundation soils, building materials that off-gas irritating chemical vapors, and the need to "bake out" new buildings prior to occupancy)

(16) Physical protection requirements

(17) Energy conservation requirements

(18) Impact of site selection

(19) Minimum fire separation between buildings

(20) Previous designation of site for another use

4-3. Sanitary wastewater collection systems

This section applies to sanitary wastewater collection systems (i.e., lift stations, force mains, collector sewers, and interceptor sewers) and building sewers (five feet beyond the building foundation).

a. System layout. Wastewater collection system layouts shall be as simple and direct as possible. Where feasible, initial planning efforts shall optimize system layouts to facilitate future system expansions, to mitigate conflicts with other utility systems, and to reduce maintenance requirements. Wastewater collection systems shall be included within utility master planning efforts. The following conditions and requirements shall be considered during route selection for new collection systems.

(1) Future population and development projects

(2) Anticipated flow rates for fully developed condition

(3) Physical constraints (e.g., utility corridors, roads and streets, buildings, geologic formations, and topographic features)

(4) Requirements of other agencies (e.g., state and local)

(5) Hydraulic design criteria

(6) Unique conditions (e.g., research and production facility operating schedules)

(7) Security boundaries and requirements

b. System design considerations. Industrial wastewater and pollutants above Environmental Protection Agency (EPA) minimal concentrations shall be excluded from sanitary wastewater collection systems except where pretreatment systems suitably remove objectionable constituents cost effectively.

(1) The following factors shall be considered in the design of sanitary sewers.

(a) Peak sewage flows from other sources

(b) Groundwater infiltration

(c) Topography and depth of excavation

(d) Treatment plant location

(e) Soil conditions

(f) Pumping requirements

(g) Maintenance

(h) Existing sewers

(i) Existing and future surface improvements

(j) Controlling service connection elevations

(2) Hydraulic design of wastewater collection systems shall comply with Technical Manuals (TM) 5-814-1, Sanitary and Industrial Wastewater Collection, Gravity Sewers and Appurtenances; TM 5-814-2, Sanitary and Industrial Wastewater Collection-Pumping Stations and Force Mains; and American Society of Civil Engineers (ASCE) 77, Design and Construction of Urban Stormwater Management Systems. All wastewater collection systems shall be designed for gravity flow unless such systems are not economically feasible. Sewage lift stations and force mains shall not be used unless approved by the responsible authority. Feasibility analyses and economic evaluations of lift station and force main costs for construction, operation, and maintenance shall be prepared and submitted to the responsible authority for approval. Sewers and force mains shall be sized to accommodate the estimated daily minimum and maximum discharges for the initial and final years of the design period specified by the responsible facilities engineering group.

(3) In accordance with ASCE 77, velocities in gravity sewers and force mains shall not exceed ten ft/s. Gravity sewers shall be designed for a minimum velocity of two ft/s, and force mains shall be designed for a minimum velocity of 3.5 ft/s.

(4) For preliminary design, domestic water consumption rates shall be used to approximate wastewater flow rates. Where possible, actual flow data from an adjacent service area typical of the service area under consideration shall be used to estimate wastewater flow rates for final design. In the absence of such data, metered water use less the estimated consumptive use (i.e., water withdrawal rate) can be used. Flow rates used in design shall be documented in the calculations.

(5) Sewers and force mains shall have a minimum depth of cover of two feet. Additional cover shall be provided to prevent freezing in cold climates, physical damage, and at roadway crossing in high traffic areas. Sewer or force main trench widths shall be minimized; however, excavations, trenching, and shoring shall comply with 29 CFR 1926, subpart P, Safety and Health Regulations for Construction. Pipe bedding specified by the pipe manufacturer shall be in place prior to installation of sewers and force mains.

(6) Sewers or force mains shall not be routed within 50 feet (75 feet in pervious soils) of any well or reservoir that serves as a potable water supply. The sewer or force main shall be ductile iron pipe in all instances where such horizontal separation cannot be maintained. Where there is a shallow depth to groundwater, special precautions shall be taken to preclude sewer infiltration or exfiltration.

(7) Where feasible, sewers or force mains shall not be routed within ten feet of potable water lines or fire water lines. Where potable water lines must cross sewers or force mains, water lines shall pass two feet above the sewer or force main. Where insufficient cover precludes such vertical separation, the sewer or force main shall be ductile iron pipe or shall be fully encased in concrete for a minimum perpendicular distance of ten feet to each side of the water line crossing. Where feasible, sewer or force main pipe joints shall not be located within three feet of such crossings, unless the joint is encased in concrete.

(8) Where feasible, sewers and force mains shall not be routed under buildings or other permanent structures. Sewers and force mains shall be adjacent and parallel to paved roadways. Sewers and force mains shall not pass beneath paved roadways except at roadway crossings. Where feasible, utility cuts within existing roadway pavement shall be perpendicular to the roadway centerline to minimize trench length. Diagonal roadway cuts shall be avoided where possible. Sewers or force mains that penetrate or pass under a security barrier through an opening of more than 96 $in.^2$ in area and over six inches in smallest dimension shall provide the same degree of penetration delay as is required for the security barrier.

c. Pipe materials and pipe joints. The selection of sewer and force main pipe material shall be based on wastewater characteristics and soil conditions. Acrylonitrile-butadiene-styrene (ABS) and polyvinyl chloride (PVC) composite sewer piping shall conform to ASTM D2680, Standard Specification for ABS and PVC Composite Sewer Piping. Plastic pipe should be considered where tree root and infiltration are a problem. Ductile iron pipe shall conform to AWWA C151, Ductile-Iron Pipe, Centrifugally Cast, for Water, and shall be used for force main and gravity sewer stream crossings. Ductile iron pipe should also be considered for inverted siphons and for sewers located in parking lots or other high traffic areas. Pipe joints shall have a permanent watertight seal. Maximum infiltration-exfiltration allowances and infiltration-exfiltration test requirements shall be specified within the contract documents.

4-4. Storm water management systems

The intent of these design criteria for storm water management systems is to promote the conservation of natural resources. This includes preserving the natural beauties of the land, streams and watersheds, hills and vegetation. This also includes protection of public health and safety, including the reduction or elimination of hazards of earth slides, mud flows, rock falls, erosion and siltation. The reduction of the impact of peak water discharges on downstream facilities by minimizing the adverse effects of grading cut and fill operations, surface water runoff, and soil erosion must also be considered.

a. System design considerations. Storm water management systems shall be cost effective and shall provide flood protection commensurate with the value and operational requirements of the facilities to be protected.

(1) The following conditions and requirements shall be considered prior to storm water management system design. In accordance with the Clean Water Act (CWA) as amended by the Water Quality Act (WQA) of 1987, the National Pollutant Discharge Elimination System (NPDES) Permit Regulations require control of point source storm water discharge.

(a) Local regulations

(b) Site topography

(c) Ultimate development within the drainage area

(d) Requirements for future expansion

(e) Outfall locations
(f) Existing drainage systems

(g) Location of other utilities

(h) Security boundary and safeguard requirements

(2) Storm water management systems shall be designed for not less than the 25-year, 24-hour storm. The potential effect of larger storms (up to the 100-year, 24-hour storm) shall also be considered. The high intensity, shorter duration storm event (e.g., six-hour storm) is nested within the 24-hour storm event. With this approach, the designer is assured of not overlooking critical events for the small headwater areas of the watershed and has also captured the critical duration for flooding at the mouth of the watershed. With the approval of the responsible authority, lesser design storms may be used where large expenditures for flood protection cannot be economically justified.

(3) Within fully developed watersheds, where the downstream capacity of existing flood control structures has been exceeded, stormwater runoff that results from developed conditions shall be detained on site (ponded) and gradually released. This is so that the capacity of the downstream channels and other control structures are not exceeded and soil erosion is mitigated.

(4) Erosion and storm water control measures shall be designed and provided in accordance with the requirements of these criteria. The erosion control plan shall be detailed on the drawings and the material and requirements included in the specifications. Areas that are being developed or excavated shall apply the following practical guidelines, fitting the various measures to the soil and topography so as to minimize soil erosion and storm water runoff potential.

(5) Provisions shall be made to accommodate increased runoff caused by changed soil and surface conditions during and after development. Erosion control measures, storm water and drainage control measures, detention basins, pipes, structures, and devices for the development shall be planned, designed, constructed, operated, and maintained so that downstream peak discharges after full development are consistent with the pre-developed condition. All storm water improvements shall be designed to sufficiently handle the estimated peak discharge rate from the site. This is so that the post-developed peak discharge rate from a 24-hour duration storm of 25-year frequency shall not exceed the pre-developed peak discharge rate from a 24-hour duration storm of ten-year frequency. Emergency spillways shall be required in the design of detention facilities to permit safe passage of storms in excess of these storm criteria. When warranted by local controlling factors (such as location within a drainage basin, protection of downstream facilities, etc.), and based on sound engineering judgement, storm water detention requirements may be modified or waived. Also, a more stringent storm frequency for the design of such improvements may be required as approved by the responsible authority. In addition, all swales, roads, etc., shall be designed to structurally carry the equivalent 100-year, 24-hour storm to prevent flood damage to nearby buildings and other structures.

(6) Wherever feasible, natural vegetation shall be retained and protected during construction. Where land must be stripped of vegetation during construction, the exposed area shall be limited to the smallest practical size and duration of exposure to the shortest practical time. Temporary soil stabilization measures shall be applied to disturbed areas when and where deemed necessary to minimize soil erosion.

(7) Permanent vegetation; improvements such as streets, storm sewers, or other features capable of carrying storm water runoff in a safe manner; and diversions, grassed waterways, grade stabilization structures, and similar mechanical control measures required for the site shall be installed as early as possible during development of the area.

b. Subsurface drainage systems by means of storm sewers shall be sized to accommodate runoff from the 25-year, 24-hour storm. Subsurface drainage systems shall be sized for a greater storm in locations where there is substantial risk to critical facilities and operations. Sediment transport requirements shall be incorporated within subsurface drainage system designs. Storm sewers shall be designed to maintain adequate scour velocities. New storm sewers shall be sized for open channel flow. The minimum storm sewer size shall be 12 inches. The minimum culvert size shall be 15 inches. For roof drain systems, the minimum pipe size for laterals and collectors shall be four inches.

c. Open-channel storm water conveyance systems shall be sized to accommodate the 25-year, 24-hour design flow with a minimum freeboard. Open-channel drainage systems shall be sized for a greater storm in locations where there is substantial risk to critical facilities and operations. Open-channel storm water conveyance systems shall be designed for minimal maintenance. The potential for scour or deposition within earth-lined channels shall be considered prior to approval by the responsible authority. Preference for earth-lined or hard-lined channels shall be based on comparison of capital, maintenance, and operation costs. Inlets to open-channel storm water conveyance systems shall be placed at locations where erosion potential is minimal.

d. Street drainage in developed areas shall be conveyed within the roadway cross section. Curb inlets shall be used to divert storm flows to surface and subsurface storm water conveyance systems. Curb inlets shall not be located within curb returns or in areas of heavy pedestrian traffic. Pedestrian and cyclist safety shall be considered during selection of storm inlet grates. Curb gaps shall be used where roadside drainage swales exist. In locations where uninterrupted vehicular access is essential to critical operational activities, roadway cross sections shall be designed to convey runoff from the 25-year, 24-hour storm such that one driving lane width (12 feet) is free of flowing or standing water. Storm water management systems shall have sufficient capacity to ensure that runoff from the 100-year, 24-hour design storm will not exceed a depth of 0.87 feet at any point within the street right-of-way or extend more than 0.2 feet above the top of curb in urban streets. Inverted crown roadway cross sections shall not be used unless approved by the responsible authority.